

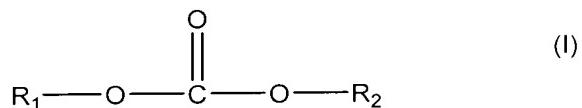
REMARKS

Claims 21-32, 34 and 36-44 are currently pending in the present application.

The rejections under 35 U.S.C. § 103(a) of: (1) claims 21, 22, 26-32, 34, 36-41 as being obvious over Shingo (JP 11-080418) in view of Cohen (U.S. Patent 4,405,394); (2) claims 23-25 as being obvious over Shingo in view of Cohen and Masahide (JP 11-005865); and (3) claims 42-44 as being obvious over Shingo in view of Cohen and Peters (U.S. Patent 5,232,954), are respectfully traversed.

Claim 21 is directed to a process for recycling expanded polystyrene comprising:

- volume reduction of expanded polystyrene by dissolution in a solution comprising a dialkyl carbonate, or a blend of dialkyl carbonates, having the following general formula (I):



wherein R₁ and R₂ are the same or different and each independently represent a linear, a branched or a cyclic alkyl radical having from 1 to 12 carbon atoms, and the sum of the carbon atoms of R₁ and R₂ is from 2 to 15;

- removal of an insoluble component, if present;
- selective precipitation of polystyrene with a non-solvent, wherein said selective precipitation of polystyrene is carried out at a temperature of 10-70°C, wherein the non-solvent is an alkylene carbonate, or a blend of non-solvents consisting of an alcohol and an alkylene carbonate, and wherein a weight ratio of the non-solvent to the dialkyl carbonate is from 2:1 to 20:1;
- separation of precipitated polystyrene; and
- drying of precipitated polystyrene.

Applicants have discovered that the process of the present invention provides for recycling of expanded polystyrene by selective precipitation of polystyrene with an enhanced efficacy in the removal of impurities including additives (e.g., halogenated flame-retardant additives). The selective

precipitation of polystyrene is carried out at a temperature of 10-70°C with a non-solvent, wherein the non-solvent is an alkylene carbonate, or a blend of non-solvents consisting of an alcohol and an alkylene carbonate, and wherein a weight ratio of the non-solvent to the dialkyl carbonate is from 2:1 to 20:1

Applicants submit that the Office has not established a *prima facie* case of obviousness.

Shingo, Cohen, Masahide and Peters, when considered alone or in combination, fail to disclose or suggest the claimed process for recycling expanded polystyrene comprising carrying out at a temperature of 10-70°C selective precipitation of polystyrene with an alkylene carbonate non-solvent, or a blend of non-solvents consisting of an alcohol and an alkylene carbonate, wherein a weight ratio of the non-solvent to the dialkyl carbonate is from 2:1 to 20:1.

Unlike the claimed invention, Shingo describes a process for recycling expanded polystyrene, wherein diethyl carbonate is listed among various solvents for *dissolving* polystyrene, while the lower alcohol is listed as the sole non-solvent for *precipitating* polystyrene (See e.g., abstract, [0011], claims 2 and 5).

Unlike the claimed invention, Cohen describes a process for laminating film-forming thermoplastic polymers to a substrate in the manufacture of printed circuit boards (See e.g., abstract, column 1, lines 9-16 and 51-68, column 2, lines 1-3, column 3, lines 16-19). The process comprises in sequential order:

- (a) rendering the copper or aluminum substrate surface clean, the cleanliness of the surface being defined by the uniform water film test;
- (b) within about 1 minute after rendering the substrate surface clean and immediately prior to lamination, applying a thin layer of liquid to form an interface between the substrate surface and the photosensitive layer;
- (c) displacing the thin layer of liquid from the interface by absorption into the photosensitive layer during lamination; and

- (d) within 30 seconds after lamination, removing the support for the photosensitive layer without delamination of the photosensitive layer from the substrate by bending the support back along a longitudinal axis of the photosensitive layer.

Unlike the claimed invention, Masahide describes using dialkyl carbonates as solvents for *dissolving* polystyrene. Nothing is said about the possibility of using an alkylene carbonate or a blend of an alcohol and an alkylene carbonate as a non-solvent to precipitate the dissolved polystyrene(See e.g., abstract).

Unlike the claimed invention, Peters describes a process for recovering an *ester-soluble* thermoplastic resin using an ester to form a mixture with a thermoplastic resin and *precipitating* the thermoplastic resin from the mixture by adding an alcohol as the *sole non-solvent* to the mixture (See e.g., column 4, lines 25-38).

Applicants respectfully submit that a skilled artisan would not have been motivated to combine Shingo with the *clearly unrelated* reference of Cohen. Shingo is directed to a process for *recycling foamed polystyrene*. In contrast, Cohen is directed to a process for laminating a photosensitive layer to a substrate in the manufacture of *printed circuit boards*.

Applicants further submit that even if sufficient motivation and guidance is considered to exist for a skilled artisan to combine Shingo, Masahide and/or Peters with the unrelated reference of Cohen, which is clearly not the case, a skilled artisan would not have arrived at the process of the present invention comprising carrying out at a temperature of 10-70°C selective precipitation of polystyrene with an alkylene carbonate non-solvent, or a blend of non-solvents consisting of an alcohol and an alkylene carbonate, wherein a weight ratio of the non-solvent to the dialkyl carbonate is from 2:1 to 20:1, as presently claimed, absent impermissible hindsight reconstruction.

Shingo is silent as to the claimed weight ratio of the non-solvent to the dialkyl carbonate being from 2:1 to 20:1. A *prima facie* case of obviousness for arriving at the claimed weight ratio of the non-solvent to the dialkyl carbonate being from 2:1 to 20:1 by routine experimentation has not been

established. A particular parameter must first be recognized as a result-effective variable before the determination of the optimal ranges of said variable may be characterized as routine experimentation. See e.g., MPEP § 2144.05(II)(B); *In re Antonie*, 195 USPQ 6, 8, 9 (CCPA 1977). Since Shingo is completely silent as to the weight ratio of the non-solvent to the dialkyl carbonate described therein, Shingo necessarily fails to recognize that said weight ratio is a result-effective variable that may be optimized by routine experimentation. Accordingly, a skilled artisan would not have been motivated to arrive at the claimed weight ratio of the non-solvent to the dialkyl carbonate being from 2:1 to 20:1 by routine experimentation, based on the limited disclosure of Shingo, absent impermissible hindsight reconstruction.

Contrary to the process of the present invention, which involves carrying out at a temperature of 10-70°C selective precipitation of polystyrene with an alkylene carbonate non-solvent, or a blend of non-solvents consisting of an alcohol and an alkylene carbonate, wherein a weight ratio of the non-solvent to the dialkyl carbonate is from 2:1 to 20:1, Shingo describes a process for recycling foamed polystyrene comprising *precipitating* polystyrene with a lower alcohol as the *sole non-solvent* (See e.g., abstract, [0011], claims 2 and 5).

Applicant respectfully traverses the Examiner's assertion at page 10, lines 1-2 of the Official Action that "Shingo discloses in the example a ratio of 3:1, reading on Applicant's claim", for the following reasons. Claim 21 recites, in part: "wherein a weight ratio of the non-solvent (*i.e.*, *an alkylene carbonate, or a blend of an alcohol and an alkylene carbonate*) to the dialkylcarbonate is from 2:1 to 20:1" (emphasis added). Applicants submit that [0016] of Shingo discloses an example using 20 g of a methanol non-solvent and 25 g of diethyl carbonate solvent, which corresponds to a *weight ratio* (not to be confused with *molar ratio*) of about 0.8:1, which does not claim 21.

Applicant respectfully traverses the Examiner's assertion on page 10, lines 6-8 of the Official Action that "Applicant submits unexpected results with example 22 using approximately 2.8 moles of butanol and 2 moles of propylene carbonate" as non-solvents compared to comparative example 20

where only butanol is used", for the following reasons. In Example 22 the weight ratio of the non-solvent (i.e., 210 g of n-butanol and 210 g of propylene carbonate = 420 g total of non-solvent) to the dialkylcarbonate (i.e., 210 g of di-n-butylcarbonate) is equal to 2:1, wherein the polystyrene solution used in Example 22 is the one prepared according to Example 19.

Contrary to the process of the present invention, which involves selective precipitation of polystyrene with an alkylene carbonate non-solvent or a blend of non-solvents consisting of an alcohol and an alkylene carbonate, Cohen describes that the liquid is to be "*absorbed*" into the photosensitive thermoplastic polymer layer (emphasis added) (See e.g., abstract). Cohen discloses that "Since rapid absorption of the thin layer of liquid is important for good adhesion, it is often advantageous to provide heat to accelerate the rate of absorption of the liquid into the photosensitive film" (See e.g., column 3, lines 16-19).

Consequently, Cohen clearly teaches that the liquid has to be absorbed into the laminated polymeric layer. This is further evidenced by the fact that Cohen discloses that "It is an essential aspect of the invention that the applied thin liquid film be substantially displaced from the interface between the photosensitive layer and the substrate during the subsequent laminating operation. This is done mainly by absorption into the laminated polymeric layer. As used herein, the term "absorption" is not used in the usual unit operations sense, but refers to the direct transfer of the thin liquid layer under lamination pressure from the interface between the substrate and photosensitive layer into the solid photosensitive layer in which it is diffused" (See e.g., column 3, lines 63-68, column 4, lines 1-2).

Accordingly, a skilled artisan would clearly understand and immediately recognize that Cohen teaches that the *liquid layer has to be absorbed by the polymer*. In contrast, the liquid (i.e., non-solvent) of the present invention, which is an alkylene carbonate or a blend of non-solvents consisting of an alcohol and an alkylene carbonate, provides for a *selective precipitation of the polystyrene*.

Cohen lists polystyrene among a plethora of various polymers that may constitute the thermoplastic polymer included in the photosensitive layer (See e.g., column 5, lines 34-68, column 6, lines 1-56). Cohen fails to provide a skilled artisan with sufficient motivation and guidance to *particularly select* the claimed polystyrene from the *tremendously large genus* of thermoplastic polymers described therein.

With respect to the Examiner's assertion at page 9, lines 6-7 of the Official Action that "Regarding to plethora of polymers: Cohen specifically uses polystyrene in Example 1", Applicants respectfully submit that Example 1 of Cohen describes a photosensitive coating composition which, among the other components, comprises a "copolymer of styrene and maleic anhydride partially esterified with isobutyl alcohol" which has absolutely nothing to do with the "expanded polystyrene" of the present invention.

Cohen discloses that "Suitable non-solvent liquids include water, fluorocarbons, aqueous and fluorocarbon solutions of alcohols, alkoxyalkanols, e.g., 2-ethoxy ethanol, and alkylene carbonates, e.g., ethylene carbonate, and aqueous solutions of heterocyclic compounds such as those described in U.S. Pat. No. 3,645,772 or other chelating agents. Particularly preferred are solutions of methanol or ethanol in water" (See e.g., column 3, lines 8-15).

Cohen fails to provide a skilled artisan with sufficient motivation and guidance to *particularly select* an alkylene carbonate non-solvent or a blend of non-solvents consisting of an alcohol and an alkylene carbonate, as presently claimed, from the various liquids described therein. Contrary to the Official Action, nowhere does Cohen disclose or suggest a non-solvent liquid comprising a mixture of an alcohol and an alkylene carbonate.

There is nothing in Cohen that would have lead a skilled artisan to particularly select not only polystyrene from the tremendously large genus of thermoplastic polymers described therein, but also an alkylene carbonate or a blend of an alcohol and an alkylene carbonate as a non-solvent for selectively precipitating the polystyrene of the present invention.

Contrary to the allegation in the Official Action that alcohols are interchangeable with alkylene carbonates, Applicants submit that a skilled artisan would immediately recognize that “alcohols” and “alkylene carbonates” cannot be considered as equivalent compounds, for at least the following reasons. An alcohol has a hydroxyl group, i.e., -OH group, which is a polar group that is able to undergo hydrogen bonding because the hydrogen atom is linked to the very electronegative element of oxygen. On the contrary, an alkylene carbonate has an alkoxy group, i.e. -OR group (wherein R may be an alkyl or aryl group but certainly not a hydrogen atom), which is less polar than the hydroxyl group and unable to undergo hydrogen bonding. Applicants respectfully submit that there is no motivation to substitute the alcohols of Cohen with alkylene carbonates or a blend of an alcohol and an alkylene carbonate to selectively precipitate polystyrene.

Applicants respectfully traverse the Examiner’s assertion on page 9, lines 14-15 of the Official Action that “Peters is used herein to show that in a typical process of drying, one increases the temperature and lowers the pressure”, for the following reasons. Peters discloses that “The mixture (i.e. *the mixture of the crushed thermoplastic resin with the ester*) is passed to an evaporating tank. In the evaporating tank, the mixture is heated to a temperature of about 110°C to 120°C” (emphasis added) (See e.g., column 5, lines 11-14). Peters also discloses that “The temperature in the evaporating tank is maintained at a temperature which does not degrade the thermoplastic resin. In one embodiment, the ester is evaporated, cooled, and returned to the dissolving tank. After removing the ester, the thermoplastic resin is cooled to recover the thermoplastic resin” (See e.g., column 5, lines 14-19). Consequently, a skilled artisan would clearly understand and immediately recognize that *the temperature refers to the evaporation of the solvent and not to the drying of the polystyrene after its precipitation by using an alcohol*. Also in the remaining part of column 5 of Peters, methods for removing the *residual ester, which is used to dissolve the polystyrene*, are disclosed.

Even if a skilled artisan were to combine Shingo with the clearly unrelated reference of Cohen, a skilled artisan would not have arrived at the selective *precipitation* of polystyrene with an alkylene

carbonate non-solvent or a blend of non-solvents consisting of an alcohol and an alkylene carbonate, in accordance with the process of the present invention, absent impermissible hindsight reconstruction, because Cohen describes *absorbing* a liquid into a photosensitive layer that may comprise various thermoplastic polymers in the manufacture of printed circuit boards.

Applicants therefore respectfully submit that a *prima facie* case of obviousness has not been established by the Office because insufficient motivation and guidance exists for a skilled artisan to combine the disclosures of Shingo, Masahide and Peters with the *clearly unrelated* reference of Cohen to arrive at the process of the present invention comprising carrying out at a temperature of 10-70°C selective precipitation of polystyrene with an alkylene carbonate non-solvent, or a blend of non-solvents consisting of an alcohol and an alkylene carbonate, wherein a weight ratio of the non-solvent to the dialkyl carbonate is from 2:1 to 20:1, as presently claimed, absent impermissible hindsight reconstruction.

Assuming *arguendo* that sufficient motivation and guidance is considered to have been provided by Shingo, Cohen, Masahide and/or Peters to direct a skilled artisan to arrive at the process of the present invention, which is clearly not the case, such a case of obviousness is rebutted by a showing of unexpected results.

As shown in Table 1 below, which compiles into tabular form the experimental data presented in Example 22 and Comparative Example 20 of the present application, Applicants have discovered that the process of Example 22, which involves selective precipitation at a temperature of 25°C of polystyrene with a blend of non-solvents consisting of an alcohol and an alkylene carbonate, wherein a weight ratio of the blend of non-solvents to the dialkyl carbonate is 20:1, in accordance with the present invention, unexpectedly exhibited superior properties with respect to surprisingly enhanced efficacy in the removal of impurities during the recycling of expanded polystyrene, as compared to the inferior properties exhibited by the conventional process of Comparative Example 20, as described in Shingo and Peters, which involves precipitation of polystyrene with an alcohol as the sole non-solvent.

Example	Non-Sovent(s)	Recycled Expanded Polystyrene	
		% Bromine Removed	% Dicumyl Peroxide Removed
Ex. 22	n-butanol and propylene carbonate	94	98
Comp. Ex. 20	n-butanol	61	92

This evidence clearly demonstrates that a process involving selective precipitation of polystyrene with a blend of non-solvents consisting of an alcohol and an alkylene carbonate in accordance with an exemplary aspect of the present invention, unexpectedly exhibited superior properties with respect to surprisingly enhanced efficacy in the removal of impurities during the recycling of expanded polystyrene, as compared to the inferior properties exhibited by the conventional processes described in Shingo and Peters, which involve precipitation of polystyrene with an alcohol as the sole non-solvent.

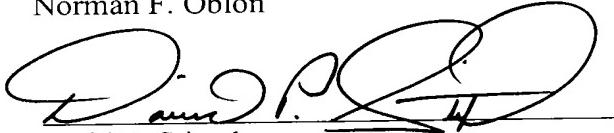
In regard to the Examiner's assertion that the examples are not commensurate in scope with the claimed invention, Applicants submit that the examples are only given for illustrative and non-limiting purposes of the present invention. Moreover, when considering whether proffered evidence is commensurate in scope with the claimed invention, Office personnel should not require the Applicant to demonstrate superior or unexpected results over the entire range of properties possessed by a chemical compound or composition. See e.g., *In re Chupp*, 2 USPQ2d 1437, 1439 (Fed. Cir. 1987).

Withdrawal of these grounds of rejection is respectfully requested.

In conclusion, Applicants submit that the present application is now in condition for allowance and notification to this effect is earnestly solicited.

Respectfully submitted,

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